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SWAN: NGC 253's Nucleated Star Bursting Environment

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Abstract. We present the first results from SWAN: "Survey of Water and Ammonia in Nearby galaxies". Nearby galaxies are conveniently located to probe molecular gas properties on scales of 10 to 200 pc, which are appropriate for the study of Giant Molecular Clouds (GMCs). The resolution of the Very Large Array in D and C configurations corresponds to a few 10s of parsecs in these galaxies. To advance studies of galaxy evolution it is paramount to understand how processes in the molecular Interstellar Medium(ISM) and star formation are linked on these scales. We have observed the metastable transitions of ammonia and the 22GHz water maser line in four nearby galaxies: NGC 253, IC 342, NGC 2146, and NGC 6946 using the VLA. These galaxies were chosen to span an order of magnitude in star formation rate, and a range of galactic ecosystems. We use the ammonia transitions to derive kinetic temperatures, which exposes the heating and cooling balance of the ISM. We then aim to relate these conditions to energetic feedback from star formation as indicated by water masers.

Currently, our analysis is focused on NGC 253. NGC 253 is a barred spiral starburst galaxy with a nucleated star formation rate (SFR) of $\approx 3\mathrm{M}_{\odot}$ per year. We use a distance of 3.9Mpc for analysis. We have observed ammonia transitions (1,1) to (5,5) and the 22GHz water maser line with a resolution of ≈63pc. We have identified nine regions across the nucleated starburst for study. The ammonia (3,3) line appears to be masing in the centermost 200pc. We have identified two regions of water maser emission. The first region is a minor axis extension, about the center of the galaxy, and is very close to the outflow. By means of these measurements, we gain an understanding of the molecular ISM associated with the nucleated starburst environment in NGC 253.

Keywords. galaxies: individual (NGC 253), ISM, starburst, masers, molecular data

1. Overview

Our goal is to understand the interplay between the molecular gas within the star forming environment. We are using ammonia to measure temperatures of the molecular gas in the ecosystem of NGC 253. NGC 253 is a barred spiral galaxy with a nucleated SFR of $\approx 3\mathrm{M}_{\odot}yr^{-1}$ Radovich et al.(2001). The nuclear starburst drives a galactic wind and molecular outflow seen by Strickland et al.(2002) and Bolatto et al.(2013) respectively. Because this galaxy is relatively close, we are able to resolve scales comparable to giant molecular clouds. We use a distance of 3.9Mpc for this study Karachentsev et al.(2003). The resolution of our VLA observations at this distance is $6'' \times 4''$ or 113pc ×75pc. This makes NGC 253 an ideal laboratory for studying the interplay between a starburst and the galaxy's ecosystem on GMC scales.

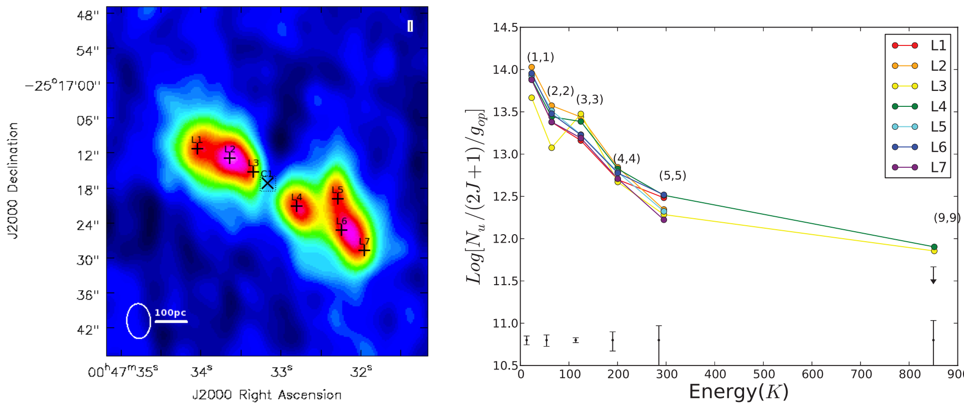

Figure 1. (Left) Integrated flux map of ammonia (1,1) line. Regions where spectra were analyzed are labeled L1-L7 and C1. C1 denotes the continuum peak. (Right) Boltzmann diagram showing locations L1-L7. The horizontal axis denotes energy above ground state plotted vs the log of the normalized column density. The average error for each individual line in is plotted in black below the data. An upper limit of $1.4 \times 10^{14} \mathrm{cm}^{-2}$ is shown for the (9,9) line by a black arrow. The slopes of the lines are indicative of T_{rot} which is corrected for to find kinetic temperatures.

2. Results

We derive rotation temperatures from ammonia metastable transitions. Locations defined by ammonia line peaks and are shown in Figure 1, locations L1 to L7 and the continuum peak by C1. Rotation temperatures are then converted to find kinetic temperatures (T) via equations in Ott et al.(2011). Figure 1 shows a Boltzmann plot of the seven clumps identified in the total intensity map. The slopes of the lines indicate rotational temperatures. The (1,1) to (2,2) line ratio is not sensitive to kinetic temperatures above 80K (Ott et al.(2011)), therefore we treat this ratio as a lower limit. Overall the temperature is consistent with a single 130-140K gas component, with minor variations from location to location. The (3,3) line is unusually strong within the central 200pc of the NGC253. We believe that this is an indication of ammonia masers in the center of the galaxy. C1 also indicates the location of a $\approx 0.5 L_{\odot}$ water maser. Well below the $10 L_{\odot}$ cutoff for AGN Tarchi et al.(2011), this maser is likely due purely to star formation.

References

Bolatto, A. D., Warren, S. R., Leroy, A. K., et al. 2013, *Nature*, 499, 450

Karachentsev, I. D., Grebel, E. K., Sharina, M. E., et al. 2003, *A&A*, 404, 93

Ott, J., Henkel, C., Braatz, J. A., & Weiß, A. 2011, *ApJ*, 742, 95

Radovich, M., Kahanpää, J., & Lemke, D. 2001, *A&A*, 377, 73

Strickland, D. K., Heckman, T. M., Weaver, K. A., Hoopes, C. G., & Dahlem, M. 2002, *ApJ*, 568, 689

Tarchi, A., Castangia, P., Henkel, C., Surcis, G., & Menten, K. M. 2011, *A&A*, 525, A91

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